Status of the PP2PP Experiment

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Summary

The PP2PP experiment at RHIC is going to measure elastic and total cross-sections in (un-)polarized proton-proton scattering. The experiment is located at the 2 o'clock interaction region (IR) of the RHIC complex. Elastic scattering at the RHIC energies, $\sqrt{s} = 200$ GeV/c and possibly 500 GeV/c during the first year, requires detection of the scattered protons at very small angles. At 57 m from the IR, where *parallel to point focusing* is satisfied, the scattering angle is directly proportional to the measured distance between the scattered proton and the beam axist, $\Theta = y_{Det}/L_{eff}$. With $L_{eff} = 20$ m the four momentum transfer range is 0.003 to 0.100 (GeV/c)^2 at $\sqrt{s} = 200$ GeV/c.

Elastic scattering requires the detection of the two collinearly scattered protons in coincidence. To measure their positions, we are installing Roman Pot stations in the two outgoing beam pipes, about 57 m on either side of the interaction region. Each station consists of two Roman Pots mounted above and below the beam centre, containing a detector package of four silicon microstrip detectors and one scintillation counter. The active area is about 80 mm × 50 mm, the position resolution better than 0.1 mm.

During the initial setup and commissioning phase, the detectors will be located 31 mm above and below the beam centre, making only a higher $|t_{min}|$ of 0.018 accessible. During a special run with reduced luminosity of $1.5\text{-}10^{28}$ cm^{-2}sec^{-1} and probably 6 bunches in each ring, the position will be at a distance of 15 mm from the beam centre. For the 6 bunches we would like to have radially polarized protons colliding in this pattern: $\uparrow\downarrow, \downarrow\uparrow, \uparrow\uparrow, \downarrow\downarrow, \uparrow 0, 00$. For further systematic studies the polarizations can be reversed via the spin flipper.

The setup will feature additional scintillation counters close to the interaction region to tag non-elastic scattering events. These counters will measure single- and double-diffractive scattering events, in the pseudo-rapidity range of $2.6 < \eta < 5.6$.

During the Year-2001 engineering run of PP2PP the main focus of the measurements will be on the total cross-section, σ_{tot}, its difference between the two transverse helicity states of the beam, $\Delta\sigma_T$, the single and double transverse spin asymmetries, A_N and A_{NN}, and the energy dependence of the nuclear slope, b. This should allow to distinguish between different exchange models brought forward for example in[1].

Assuming a cross section of about 40 mb would lead to an expected physics event rate of about 600 Hz, the trigger rate being probably higher at around 1 kHz. For the above mentioned bunch fill pattern we would collect about 300,000 events per hour and pattern. Hence, a store of about 10 hours would be sufficient for our measurements. If also 250 GeV/c become available, we would like to have additional beam time with reduced luminosity at that energy.

At present the production, assembly, and testing of the detectors measuring the vertical position of the scattered protons is underway. The assembly of the horizontal detectors is going to start in a few weeks. The Roman Pots will be available by November 26 at the switch-over time to proton running, as will be the inelastic detectors, which had been previously mounted and tested.

[1] N. Buttimore et al, PRD 59:114010 (1999) and E. Leader and T. Trueman, PRD 61:077504 (2000)

Measurements for Engineering Run in Year-1

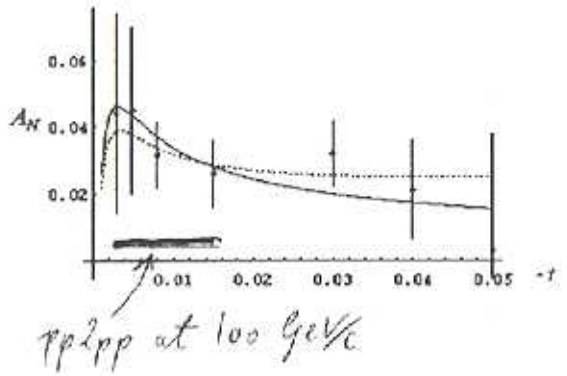
Kinematic coverage:

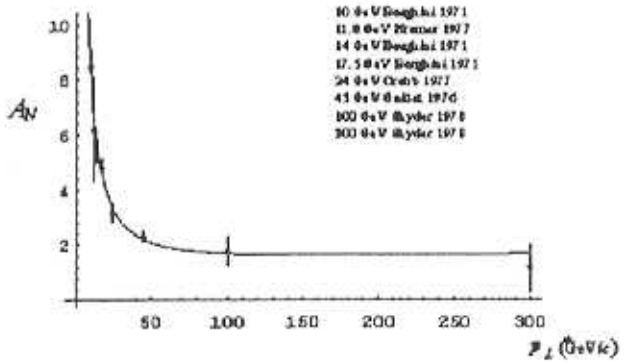
- at 100 GeV/c: $0.003 < -t < 0.015$ (GeV/c)^2
- at 250 GeV/c: $0.006 < -t < 0.100$ (GeV/c)^2

- Study CNI region, $\sigma_{tot}, A_N, A_{NN}$
- s and t dependence of the nuclear slope, B
- Measurement of A_N over large $-t$ range to find suitable kinematic region for polarimetry

Analyzing Power A_N

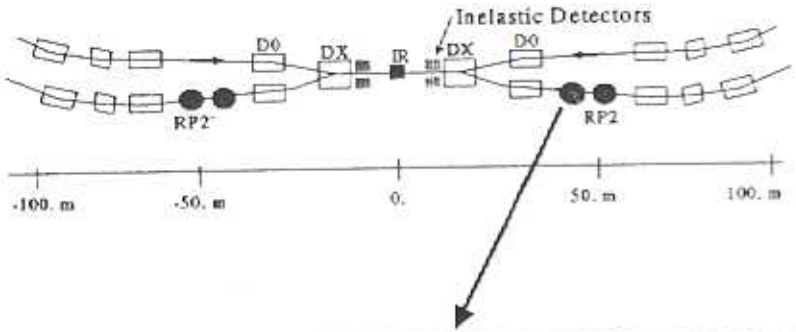
THE SPIN DEPENDENCE OF HIGH-ENERGY PROTON SCATTERING.
N.H. Buttimore, B.Z. Kopeliovich, E. Leader, J. Soffer, T.L. Trueman
Phys.Rev.D59:14010,1999

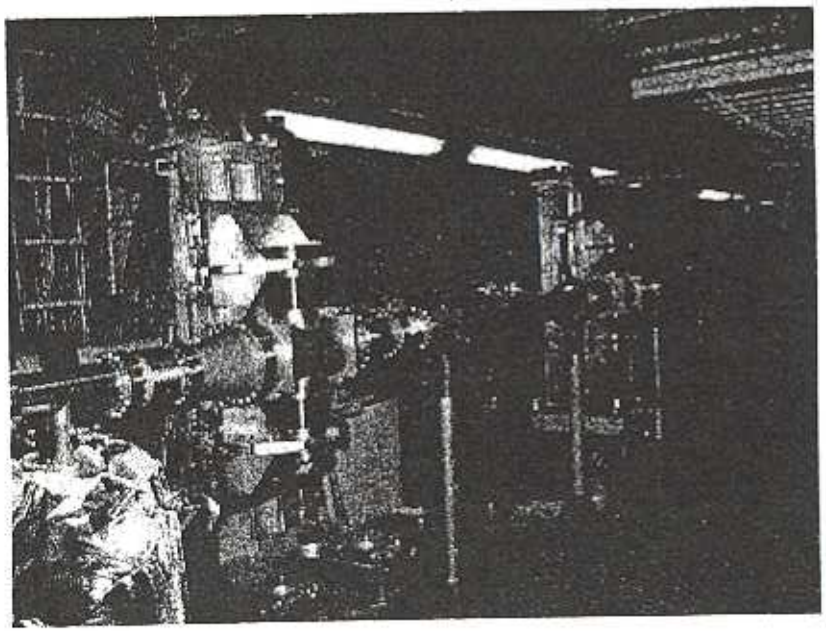




Layout of the Experiment

Roman pot location is determined by parallel to point focusing.





Expected Run Plan

- Set up and commissioning concurrent with other experiments at a 'safe' distance (3.1 cm from beam centre)
- **Special low intensity run for pp2pp** (1.5 cm from beam centre)
  - Total proton intensity $\approx 1.5 \cdot 10^{11}$ (6 bunches)
    → $L \approx 1.5 \cdot 10^{28}$ cm^{-2}sec^{-1}
  - Radial polarization direction
  - 600 Hz physics rate for ~40 mb cross-section (2 million events per hour)
  - Assume 6 bunches with fill pattern

    ↑↓ ↓↑ ↑↑ ↓↓ 0↑ 00

    → 300,000 events per hour and pattern
  - Need 1 beam store of about 10 hours (for each beam energy?)
  - Would like 2 hours during commission early

Status of Experiment

- Vacuum parts for all four Roman Pot stations installed (Roman Pots to be installed during switch-over time)
- Infrastructure mostly on place
- Production of silicon detector assemblies started (first Y-detector assembled and aligned last week)
- Testing of detectors to begin this week
- Silicon detector wafers being manufactured at InstDiv (new batch available beginning 3 weeks from now)
- DAQ work underway (Dima and Igor arrived)
- Inelastic detectors installed, tested, and dismantled again for Au-Au running
- Plan to install Roman Pots in November

Outlook

2003

- Extend measurements to $0.1 < -t < 1.3$ (GeV/c)^2

Beyond 2003

- Measure in CNI region, requiring special tune $0.0004 < -t < 0.12$ (GeV/c)^2
- Measure in large -t region $1.3 < -t < 5$ (GeV/c)^2
- Elastic scattering of proton-deuteron, deuteron-deuteron, and proton-^{4}He also possible

Stephen Bültmann RHIC Spin Collaboration Meeting BNL October 1, 2001